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Designing communication: Politics and practices of participatory water quality governance

Matthijs Kouw

PBL Netherlands Environmental Assessment Agency & VU University Amsterdam, Institute for Environmental Studies
E-mail: matthijs.kouw@pbl.nl

The use of technologies to furnish participatory forms of water governance can lead to the exclusion of knowledge and social groups. This paper examines the so-called 'WFD Explorer' – a software package developed to facilitate communication about water quality governance between experts and non-experts in the Netherlands. Drawing on work from Science and Technology Studies (STS), I show how the design and subsequent implementation of the WFD Explorer shaped participation, leading to the exclusion of knowledge and social groups from water quality governance. Developing and implementing technologies of participation is not just a technical matter, since participatory water governance also involves conflicts of interest between social groups that cannot be resolved easily. Those involved with participatory water governance need to study the potential exclusion of knowledge and social groups that can accompany the design and implementation of technologies used to enable participatory governance.

Keywords: governance, participation, modeling, exclusion, WFD Explorer.

1. Introduction: contextualizing participation

In water governance, participation is often seen as a promising way to enhance decision making and policy making. Participatory governance can be contrasted with more established 'technoscientific approaches' (Wyatt & Henwood, 2006, p. 233), which assume risks can be measured and weighed objectively by means of quantitative methods that calculate the likelihood of exposure to risks and the subsequent impact of the occurrence of those risks. Technoscientific approaches are based on a "deficit model of lay people's understanding" (Ibid.), which dictates that "people should be given more information from experts and if this is then correctly interpreted, irrational fears will disappear and lay views or 'perceptions' will come to resemble more closely the objective understandings of experts (the 'real' risks)." (Ibid.) Thus, technoscientific approaches are geared towards expert assessments of risks, and value the latter as the only approach to risk that is systematic, thorough, and objective.

Several authors working in the field of Science and Technology Studies (STS) have argued the deficit model of risk is running out of steam, in particular in terms of recognizing or responding to controversies concerning science, technology, and expertise. (Callon, Lascoumes, & Barthe, 2009; Jasanoff, 1990; Wynne, 1996) Such controversies call for extended public participation: "a pithy summary of this aspiration is that the technical is political, the political should be democratic, and the democratic should be participatory." (Moore, 2010, p. 793) In water governance, public participation is applauded since it "would improve the quality of decision making by opening up the decision-making process and making better use of the information and creativity that is available in society." (Huitema et al., 2009) Thus, participation can establish more democratic forms of water governance by allowing various social groups to voice their opinion, which might unsettle traditional hierarchies in science and politics.

Discussions about participatory water governance are often embedded in a discourse that draws heavily on potentials attributed to new technologies. Examples of such technologies are dynamic and interactive visualizations of possible outcomes of flooding, and 'serious games' used for educational purposes, both of which are seen as promising instruments to address the complexity of pressing and topical water-related issues (Harteveld, 2011; Hoeven, Aerts, Klis, & Koomen, 2009; van Schijndel, 2006; Valkering, Tàbara, Wallman, & Offermans, 2009). This use of technologies to furnish participatory forms of governance can be aligned with 'design thinking' (Brown, 2008), which implies technologies can be used to re-organize and democratize companies and institutions, and improve their ability to cope with societal issues.

1.1. The WFD Explorer

In this paper, I study the development and reception of the so-called 'WFD Explorer': a communication instrument developed in order to facilitate discussions concerning the European Union's *Water Framework Directive* (WFD), which aims to prevent the deterioration of aquatic ecosystems, protect or enhance the status of aquatic ecosystems, promote sustainable water use, and enhance protection and improvement of the aquatic environment. These objectives can be achieved "through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances." (European Union, 2000, p. 5) Article 14 of the WFD (Ibid. p. 16) stresses that interested parties can and should be provided with information, leading to shared decision making. Active involvement of such parties meets the legal requirements of the WFD, improves decision making by attuning governance to the concerns of those involved, and increases the willingness of these parties to accept and implement policies thus developed (Mostert et al., 2009, p. 35). In this vein, the WFD Explorer was intended as an instrument of governance that provided stakeholders, decision makers, and policy makers with the means to collaboratively explore and understand relationships between objectives prescribed by the WFD, the range of possible (sets of) measures, and the impact of those measures.

In practice, the intended use of the WFD Explorer did not work out as its developers intended. Disagreements among these developers, ecologists and biologists, and users responsible for implementing the WFD Explorer in their organizations precluded the WFD Explorer from reaching its intended audience. Many users questioned the potential of ecological modeling and lamented the WFD Explorer's lack of adaptability and transparency. In addition, differences between 'expert' users and 'non-expert' users turned out to be difficult to bridge. From the perspective of constructivist technology studies, the observation that technologies were not adopted by their intended audience is not so much a case of design failure or technological malfunctioning, but rather a moment of slippage where diverging interpretations and commitments can be identified and studied (Bijker, 1995; Pinch & Bijker, 1984; Wyatt, 2008). The fact that the WFD Explorer did not reach its intended audience as a moment of failure, I discuss its development and reception in order to study diverging opinions about participatory water quality governance and modeling more generally. As will become clear, the interests of the various social groups involved with the design and implementation of the WFD Explorer do not bode well for celebratory accounts of participation, which would see the WFD Explorer (and technologies used for participation more generally) as an unambiguous and politically neutral way to enable democratic forms of governance. How can this relationship between technologies and participatory governance be framed?

1.2. Technologies of participation

In the context of the implementation of the WFD in the EU, participation is seen as a politically legitimate move since it is 'inclusive' in the sense that it features knowledge from a multitude of social groups, which supposedly ensures the concerns of these parties are met. In the following, I return to this inclusive aspect of the WFD Explorer to describe how the attempt to include a multitude of knowledge and actors turned out. However, participation may entail different roles for these parties: whereas some social groups get their knowledge included in governance, others only get the opportunity to engage governance in a manner pre-determined by other social groups and/or technologies. Values about the form and content of participatory governance reverberate through the design of technologies used to enable participatory governance. A given technology of participation can be seen as an 'instrumentalization' of political goals (Feenberg, 1999, 2002; Feng & Feenberg, 2008). Instrumentalization theory can be described as "a critical version of constructivism that understands technology as designed to conform not just to the interests or plans of actors, but also to the cultural background of society." (Feng & Feenberg, 2008, p. 112) Instrumentalization theory can reveal technological standards, or 'technical codes' (Ibid. p. 115), which harbor social demands that have shaped the design of technologies. According to Feng and Feenberg, it is the task of researchers to excavate the norms that shape technological designs: "by questioning technology vigorously, we can help open a space for designing technology differently." (Ibid. p. 117, original emphasis) As several authors have argued in this vein, the technological means of political decision making and governance need to be subjected to scrutiny to understand how technologies shape political practices (e.g. Barry, 2001; Braun & Whatmore, 2010; Marres & Lezaun, 2011; Moody, Kouw, & Bekkers, 2013; Whatmore & Landström, 2011).

What ‘technical codes’ are relevant in the case of the WFD Explorer? A precondition of the WFD Explorer is that the perspectives of various social groups needed to be accommodated in order to enable participatory governance. However, questions about what knowledge and what social groups needed to be included in the design of the WFD Explorer did not settle. Priorities and responsibilities were structured around the team of developers, there were differences concerning the data that the WFD Explorer’s developers considered to be relevant for water quality governance, and hierarchies between relevant social groups, such as developers, ecologists, and the model’s intended users, turned out to be rather persistent and re-enacted during the development of the WFD Explorer. When such conflicts are encapsulated in the form of a stable technology used for participation that is left unquestioned, disagreements about water quality governance are depoliticized, even though a particular form of water quality governance that may become hegemonic is put in place.

1.3. Research questions and methodology

In the following, I address the development and reception of the WFD Explorer through three questions, which correspond to sections 2 to 4 of this paper. First, how did development of the WDF Explorer commence and how did the social groups involved interact during the developmental phase? Second, why did its prospective users refuse to adopt the WFD Explorer, causing it to fail in reaching its intended audience? Third, to what extent does the failure of the WFD Explorer to reach its intended audience indicate the likelihood of success of participatory forms of water quality governance? I address these questions for two reasons. First, I problematize the currently dominant ‘design thinking’ in water quality governance and water governance more generally, which I alluded to above. Second, in order to enable inclusive forms of governance, the development of technologies in the context of participatory water governance needs to incorporate ‘non-technical’ elements, i.e. the diverging perspectives of various social groups involved with participatory water governance.

In answering these questions, I draw on a total of 22 semi-structured interviews conducted between 2009 and 2011 with both developers of the WFD Explorer and some of its prospective users. These interviews were part of PhD-related research on how simulations and models make knowledge of risks more or less visible, and to what extent their use makes technological cultures susceptible to risks. Development of the WFD Explorer primarily took place at Deltares, a Dutch institute for applied research in the field of water, subsurface and infrastructure based in *Delft* (The Netherlands), which was also the main site of my PhD-related fieldwork. The group of people responsible for the WFD Explorer’s development features a variety of backgrounds that include ecology, marine biology, and software engineering. The prospective users I interviewed worked at a governmental body responsible for implementing water quality policies located in *Breda* (The Netherlands). During the interviews, I addressed issues related to the development and reception of the WFD Explorer, in particular how the various groups involved (e.g. developers, ecologists, and policymakers) interacted during the development of the WFD Explorer and how they responded to its design. In addition to the qualitative interviews, I observed discussions between the participants of an introductory workshop, which was aimed at making a wider audience familiar with the WFD Explorer. The workshop enabled me to witness some of the concerns of prospective users of the WFD Explorer without my presence as a researcher interfering with the participants' discussions. Finally, since development of the WFD Explorer started as early as 2004, I needed to study policy documents and workshop reports to gain familiarity with the events that transpired before I commenced my study of the WFD Explorer.

2. From prototype to implementation: meeting local requirements

How did development of the WDF Explorer commence and how did the groups involved interact during the developmental phase? Although the developers of the WFD Explorer went at great lengths to meet the requirements of prospective users, these requirements diverged to the extent that they could not all be met in the version of the WFD Explorer that was eventually released.

The development of the WFD Explorer commenced in 2004 in order to address the myriad of problems and measures related to water quality, and at the same time allow policymakers, decision makers, and stakeholders to devise policies pertaining to water quality. The latter is determined by a number of factors: the runoff and emissions of natural and toxic substances, chemical processes (decay of substances and adsorption), physical processes (sedimentation and resuspension), biological processes (bacteria, algae), hydrology (flow and water level), morphology (sediment, shape of river banks), meteorology (temperature and radiation), water management (discharge and intake of water), and other anthropogenic factors (such as fishing, harvesting, and dredging). All aspects of water quality need to be taken into account when studying the cause and possible solutions for ecological issues. For example, water-related diseases can be met by implementing sanitation systems that remove diseases such as cyanobacteria.

As a response to the diversity of ecological phenomena, water quality-related issues, and the measures that can be taken to improve water quality, the WFD Explorer enabled decision-making in the form of a shared and standardized instrument. The 'technical design' (see introduction) of the WFD Explorer thereby encapsulated political ideas about the WFD and participation. The introduction of the WFD Explorer could establish uniformity in the design of programs of measures, making policymaking more consistent in the varied landscape of water quality governance in the Netherlands: there are 25 Water Boards (local organizations responsible for water management), who may wish to pursue their own agendas. By using a shared and standardized instrument, the regional water authorities would make the process of implementing measures more efficient and transparent in the eyes of the European Union (Consortium WFD Explorer, 2005).

When development of the WFD Explorer commenced, it needed to be able to facilitate negotiations between stakeholders, employees of the Water Boards, policymakers, and ecologists. The WFD Explorer therefore needed to quickly provide an accessible overview of possible measures rather than highly accurate predictions of the effects of those measures. Low detail analyses and rough schematizations guaranteed low computational requirements, allowing quick and interactive exploration of different scenarios. The first version of the WFD Explorer was based on a largely standardized calculation core, database, and mathematical equations. Still, users could change parameter values and adopt the WFD Explorer to their demands, provided they were familiar with the model's design. A database with region-specific information formed an additional third component of the WFD Explorer, allowing users to enter area-specific information and thereby adapt the WFD Explorer to local requirements.

The developers attempted to meet the demands of their intended user base as well as possible during the early stages of the development of the WFD Explorer, e.g. by organizing meeting to discuss user requirements. A steering group was established that included representatives of the various Water Boards and developers of the WFD Explorer. Additional meetings between the prospective users and developers were organized in order to exchange ideas for improvements and share experiences. However, such meeting did not always lead to a successful inclusion of additional knowledge and extended participation. Expert meetings were organized for ecologists and biologists to make up for gaps in knowledge and involve them as a user group, but only those who were sympathetic to the WFD Explorer would actually show up. In addition, the developers based their improvements to the WFD Explorer on personal preferences and expertise, rather than putting their ideas up for negotiation or implementing unanimously accepted scientific knowledge. The developers were aware that some knowledge that was supposed to be included in the WFD Explorer was simply not available yet (Lagacé, Holmes, & McDonnell, 2008). Despite the fact that such knowledge gaps were acknowledged, idiosyncratic approaches eventually ended up in the WFD Explorer's design.

It is important to be sympathetic towards the concerns of the WFD Explorer's developers in this respect, since the negotiations demanded more and more from them: including the ideas of experts working at the various Water Boards in the WFD Explorer's design implied a growing and more challenging list of requirements. The developers became more ambitious, even though some prospective users by now struggled to keep up with the many updates and alterations to the WFD Explorer. Meanwhile, the WFD Explorer was advertised as a promising tool for the implementation of the WFD by national-level policymakers and members of agencies funding the development of the WFD Explorer. This further increased the value attributed to the WFD Explorer, and thereby also exerted more stress on the WFD Explorer's developers. By now the stakes were high indeed.

The inclusive character of the WFD Explorer's development had its toll. The developers could not incorporate all of the changes suggested by the users and meet the new standard of quality they partly inflicted on themselves (though not deliberately). A first version of the WFD Explorer was released in March 2007. Increased user participation through peer reviews and the resulting updates created an abundance of versions of the WFD Explorer. Whereas some users complained about the degree of standardization in water quality modeling inflicted by the WFD Explorer, others lamented the lack of a clear direction in the whole process. Users experienced complications due to the many updates of the WFD Explorer, e.g. conflicting results in the output of different versions of the WFD Explorer that led users to question the reliability of the model and its design, difficulties in changing the input values to adapt the WFD Explorer to particular region, a user interface that many experienced as confusing. In response, the developers included new functionalities and improved the reliability of model output, which unfortunately increased the amount of time for the WFD Explorer to perform its calculations and made the underlying model calculations more complex. As a result, the WFD Explore became appropriate for users who were not knowledgeable in the fields of ecology, biology, and water quality modeling.

Despite the attempts of the developers to meet the requirements of their users, the latter did not have the possibility to influence the instrument until it was too late and a design was already firmly in place. The developers wanted to complete the development of the WFD Explorer in time, and focused on delivering the instrument while devoting more attention to user demands as well, e.g. by providing on-site assistance. Still, users did not adopt the WFD Explorer. The updates never fully encompassed the requirements of the users, and users felt there was insufficient time to become accustomed with the model (Reeze & de Vlieger, 2009).

3. Transparency and model skepticism

As shown above, the developers of the WFD Explorer were unable to accommodate the full range of the desires of a varied user base, which did not bode well for the willingness of these users to adopt the WFD Explorer in their work. Why did the WFD Explorer fail in reaching its intended audience? As I show below, there are two main reasons for this. First, users felt they were dealing with an instrument that functioned too much like a black box to their taste. Second, many users felt models were not suitable to study phenomena related to water quality, and did not deserve such a prominent place in the context of water quality governance in the first place.

The users of the WFD Explorer who were at this point responsible for the customization to the specificities of particular areas were familiar with water quality modeling. Though the first release of the WFD Explorer delivered outcomes that were seen as ‘strange and inexplicable’ (Reeze & de Vlieger, 2009, p. 20), this was not a complete surprise to those involved. The quality of knowledge rules related to chemical processes was generally considered to be good. However, as indicated above, many ecological knowledge rules were based on estimations and assumptions, were still in development, and were largely aimed at providing rough overviews of systems on a relatively large scale. These shortcomings in the WFD Explorer’s calculation rules made its prospective users question its output.

But what really raised suspicion on the part of prospective users was their inability to study the technical design of the WFD Explorer. In other words, users were unable to question the WFD Explorer’s technical code. Although the documentation of the WFD

Explorer explicitly discussed uncertainties pertaining to the underlying calculations, the user interface did not provide such information. Many users understood how knowledge gaps problematized the development of mathematical approaches to water quality, and did not blame the developers for being unable to solve this issue. What they did lament was that a lack of transparency of the design of the WFD Explorer prevented them from figuring out the sources of errors and uncertainties in the output of the model. Regarding this lack of transparency, one ecologist working on integrated water management at the Water Board *Brabantse Delta* in *Breda*, The Netherlands, remarks that the value and exactitude of the model depend on its controllability: ‘the reliability is dependent on your insight into model data and calculations . . . if you cannot understand the model in a straightforward manner you might as well throw it out.’ (Interview June 12, 2009)

What is more, the rough representations of the WFD Explorer did not correspond with this ecologists’ highly detailed knowledge of the area that fell under his responsibility. Complex ecosystems are represented as a single, homogenous body of water, potentially leading to the assumption on the part of other users of the WFD Explorer that they are indeed dealing with a homogenous system. Local phenomena and contextual knowledge are not deliberately excluded from the WFD Explorer, but they do not form an immediate starting point for its developers. Their systemic approach implies they start from a national context that can later be adapted to meet local requirements. Many ecologists have expressed their concern about this method, and simply refused to work with the WFD Explorer since they could not identify with its approach to ecological phenomena.

As much as the multitude of approaches, perspectives, and opinions on the part of the Water Boards may make the implementation of the WFD on a national level more problematic, forcing users to approach water quality-related issues in a homogenous way that applies to the entire Netherlands provoked criticism. Inappropriate levels of detail omits knowledge from ecological models (e.g. Pilkey & Pilkey-Jarvis, 2007), and models used to understand water quality in particular. Prospective users of the WFD Explorer stressed this issue, and emphasized the need for contextual knowledge, rather than the more general ‘systemic’ approach dictated by the WFD Explorer. Such objections harbor more profound epistemological claims about the extent to which ecosystems and water quality can be modeled. Ecologists and biologists are often more skeptical towards modeling, and claim that knowledge of ecosystems is based on highly contextual knowledge. In addition, skeptics emphasize the recalcitrance of ecological phenomena by stressing the latter’s ‘complexity’, and portraying ecological knowledge as ‘uncertain’ due to the plethora of interacting processes. The quality of models that address water quality is further compromised due to the time it takes for effects of measures to become apparent: restoring an ecosystem may require more than simply eliminating the conditions that have led to its demise, and there may be factors that contribute to a healthy ecological status that are unknown at the moment.

Despite the complexities and uncertainties that are attributed to knowledge about ecosystems, the EU stresses that participatory water quality modeling requires disclosing such knowledge about bodies of water and their ecological status to stakeholders, employees of the Water Boards, and policymakers in the form of a more systemic and standardized approach:

> "Common principles are needed in order to coordinate Member States' efforts to improve the protection of Community waters in terms of quantity and quality, to promote sustainable water use, to contribute to the control of transboundary water problems, to protect aquatic ecosystems, and terrestrial ecosystems and wetlands directly depending on them, and to safeguard and develop the potential uses of Community waters." (European Union, 2000, p. 3)

The development of a standardized approach to water quality monitoring is highly controversial among some ecologists and biologists, but certainly not all. As one water quality expert working at Deltares explained: '[the model] might not be valid in terms of that particular species of fish that swims around somewhere, but it does describe the bulk of the system.' (Interview April 29, 2009) This pragmatic approach to ecological modeling may justify the use of standardized approaches to water quality modeling, provided they yield a sufficiently accurate answer to the question at hand. Another ecologist working at Deltares admits that biology and ecology feature many 'differences' that cannot be approached in a straightforward homogenous manner:

> "If I explain to a biologist that I took a certain approach which led me to propose certain conclusions, he will mention that a particular observation he made cannot corroborate my findings. That is really the default answer of ecologists . . . it is as if they look for differences rather than similarities." (Interview May 6, 2009)

In a similar vein, an ecologist working at the aforementioned Water Board *Brabantse Delta*, stressed the value of standardized approaches since they force 'ecologists to make their knowledge and ideas exchangeable and transparent, implying a more objective approach.' (Interview May 19, 2009, emphasis mine)

The water quality modeling expert currently leading the development of the WFD Explorer at Deltares also refers to the potential disadvantages of a persistent emphasis on the multiplicity, complexity, and uncertainty featured in the work of many ecologists:

> "There is a tendency for [models] to become more complex, making them more difficult to understand, we throw more at these models, making their output more difficult to understand . . . I would not mind performing calculations on a more detailed scale, but then I would also like to see a handy aggregated version of the model's output. Otherwise you simply lose track." (Interview June 18, 2009)

In other words, simplified models may give a rough representation of complex phenomena, but that does not make them superficial or useless in a strict sense.

As became clear above, the political goals instrumentalized in the WFD Explorer (i.e. through standardized approaches to water quality that omitted properties particular to local systems) were not only embraced by members of the political arena, but also by many developers. Simplifications were necessary for the WFD Explorer to function in policy contexts, which is where the agendas of developers and national-level policymakers appear to meet, since both stress the value of standardized approaches to water quality modeling in the form of general and systemic approaches. For national-level policymakers, an important advantage is that developing a tool like the WFD Explorer can facilitate consensus between the various parties involved in implementing the WFD. Using a shared platform for water quality modeling can enable negotiations and thereby may be able to establish the uniformity needed to successfully implement the WFD.

In retrospect, the developers perhaps focused too little on the requirements of the employees of the Water Boards, who actually provided specialist knowledge on water quality, which points to a discrepancy between perceived and actual usage. These employees have an important role in mediating between the developers and the policy arena, and had strong opinions about the WFD Explorer based on their own local expertise and requirements. The key difference concerned an opposition between those who preferred a systemic approach to water quality modeling (e.g. national-level policymakers, the developers of the WFD Explorer, but also some ecologists and biologists), and users who were critical of this approach and were in favor of more contextual methods. For the WFD Explorer to become a successful policy instrument, the Water Boards needed to accept it unanimously. Although the national and systemic approach to water quality sufficed in the eyes of the developers, each Water Board had its own preferences, organizational culture, and tricks of the trade that it wanted to incorporate into water quality governance.

The conflicts described in this section reveal a more profound issue. What counts as 'working' consists of only partially compatible ideas among policymakers, developers, and prospective users working at the Water Boards. For some ecologists and biologists, the systemic approach prescribed by the WFD Explorer was unacceptable: ecology needs to start from the level of individual bodies of water. According to these ecologists and biologists, a model is simply nonsensical if it is not based on the particularities of local situations - that is, if one decides to use a model at all. In the case of the users who did want to use the WFD Explorer, it was not always clear for the developers how to meet their requirements. Some users simply wanted a repository of representations of ecosystems, measures, and the costs of measures they could experiment with, while other users wanted a model that would propose measures to them, based on the requirements of the WFD. Yet another group wanted a model that could analyze water quality-related issues in detail. In sum, the technical code of the WFD Explorer turned out to be only partially compatible with the range of ideas and opinions of its user base, which was partly due to divergent interests of those involved.

4. Thresholds of expertise

To what extent does the failure of the WFD Explorer to reach its intended audience indicate the likelihood of success of participatory forms of water quality governance? Making the technical codes concomitant with technologies of participation more inclusive hinges on an understanding of how expert communities are established. As Brian Wynne has argued in great detail, knowledge provided by expert communities should not be taken at face value. Rather, the ways in which expert communities are established involves "questions of how definitions of public issues are established and maintained, and thus what becomes salient and what is deleted from collective attention." (Wynne, 2002, p. 405) To illustrate, modelers often stress expertise is required to work with models, and feel that 'non-experts' are unable to use models in responsible manner. This conviction reveals that many modelers do not think policymakers are up to the task to properly deal with the WFD Explorer. Thus, the failure of the WFD Explorer to reach its intended audience should not only be framed as a technological issue that can be resolved by new and improved technical design. Furnishing participatory governance is as much about developing technologies as it is about bridging gaps between the social groups involved.

A new version of the WFD Explorer has been in development since 2009 as a response to the difficulties encountered in implementing the first version. Whereas the first version of the WFD Explorer focused on enabling communication and delivering interactive and low-detail analyses, the new version of the WFD Explorer emphasizes more thorough analysis, thereby providing a more substantial and scientific basis for water quality governance. The new version of the WFD Explorer is not so much directed at participation, but rather at further enhancing knowledge of phenomena related to water quality. The developers still intend to create a version of the WFD Explorer that functions as an instrument for participatory water governance. However, they also admit that this can only become a reality after the instrument has been further enhanced and accepted by the varied group of prospective users. The developers expect that enhancing the scientific quality of the WFD Explorer will increase its viability as a tool for participatory water quality governance.

However, it is questionable whether technical improvements will successfully establish participatory water quality governance. The fact that most Water Boards expressed interest in using the WFD Explorer can be seen as proof of a demand for such an instrument. However, this demand was not shared unanimously. An important reason for Water Boards to use the WFD Explorer was that they needed to meet requirements related to the WFD. Attempts to enable collaborations between those responsible for the development of instruments of governance and their audience require "frequent and intense dialogue" and may improve "the mutual understanding of each others [sic] problems and considerations." (Icke, van Heeringen, Groot, & Ouboter, 2006, p. 112) Enhanced communication between modelers and water managers can be enabled by "agreement on modeling objectives in advance of applications . . . mutual understanding of the capabilities of model codes and the requirements of management tasks . . . selection of appropriate model codes . . . an appropriate assessment of performance to determine model credibility" (Hutchins et al. 2006, p. 19), although good outcomes cannot be guaranteed.

However, water quality modeling experts do not always approach the transfer of their knowledge to policy arenas as optimistically as the foregoing authors suggest. A problem that is often mentioned is the difference between the priorities of modelers on the one hand and stakeholders, decision makers, and policy makers on the other. This issue has already featured in the previous section: national-level policy makers saw the WFD Explorer as a powerful way to standardize water quality governance that would bring about agreement, efficiency, and political credibility. However, various prospective users of the WFD Explorer were skeptical of attempts to develop general solutions for water quality-related issues. A related issue is the way in which these different social groups evaluate the outcome of models: whereas water quality modeling experts tend to interpret the output of models as a rather provisional form of knowledge, decision makers and policy makers intend on grounding their decisions on model output and demand clear-cut answers.

According to one water quality modeling expert at Deltares explained, there is no straightforward recipe for more reliable models. Policy makers may be inclined to see models as a way to understand and predict the behavior of various aspects of systems, including ecological phenomena:

> "Everything needs to be in there, including ecology. Of course that means that those models become more and more complex . . . you have to keep thinking about your model, how will you put that reality into your model? That model will always be a simplification . . . of reality. And in how far you can capture that in your chosen variables, that is the question, that is actually the uncertainty." (Interview April 29, 2009)

Water quality modeling experts emphasize the value of the WFD Explorer in terms of its ability to provide insights into the inner workings of ecosystems. Rather than seeing the output of the model as a solution to a particular problem, they tend to approach it as an invitation to test their own ideas, assumptions, experience, and when necessary perform additional research.

All water quality modeling experts stress that one needs to understand how models work in order to use them. This also means that personal experience and knowledge are seen as crucial ingredients to using models in a responsible manner. Water quality modeling experts are quite eager to stress the provisional, exploratory nature of their activities, and will always judge model output on the basis of experience and tentative ideas, unlike some members of their audience. An ecologist working at Deltares explains this issues as follows:

> "The danger with building more and more complex model is that they are seen as representative of reality, that you cannot see anymore where the uncertainty is . . . it helps in your analysis of the system. But policy makers will see it as a representation of reality, like 'the model says', then it becomes certainty . . . "we do not have complete knowledge of the system, how things interact . . . you can do a lot of calculations based on your assumptions, which yields an answer, but you have to keep thinking about your assumptions." (Interview April 29, 2009)

The ability of model users to critically approach model output forms a criterion by means of which water quality modelers differentiate between 'experts' and 'non-experts'. As an ecologist working at the Water Board *Brabantse Delta* explains:

> "It all depends on whether you are dealing with an expert or a policymaker . . . an expert knows very well that a model is a model and that it has its limitations. However, policy makers [. . .] cannot understand those models, that is impossible [. . .] yet they are confronted with the output of models. I think they are unable to say, yes, it is true what the model calculated, it is good or bad. In other words, they thus become dependent upon experts who are knowledgeable." (Interview June 12, 2009)

Water quality modeling experts frequently refer to the importance of expertise when describing their encounters with their audience and it is not uncommon for them to draw boundaries between 'those in the know' and a 'lay audience'. Differences between these social groups are not given, but rather enacted in order to establish boundaries between experts and non-experts. A senior hydrologist working at Deltares even argues that lay audiences may acquire a more or less coherent overview of an issue, but their knowledge lacks depth (Interview June 12, 2009).

The relationship between water quality modeling experts and their audience does not just relate to distributions of (expert) knowledge, but also how different social groups involved with simulation practice characterize each other. Some water quality modelers have the desire to develop tools to educate stakeholders, employees of the Water Boards, and policy makers, while others repeatedly refer to boundaries related to priorities and experience that may preclude stakeholders, employees of the Water Boards, and policy makers from making informed decisions. Although many interviewees did not rule out participatory forms of water governance, they did point out complications with differing degrees of severity. 'Expertise' appears to be a notion that draws boundaries between different user groups, based on how 'experts' experience their interaction with 'non-experts': users of the WFD Explorer need to have the expertise required to evaluate model output 'responsibly'. In sum, boundaries between expert communities and their 'lay audience' can be difficult to bridge, limiting the inclusive potential of participatory water governance.

5. Conclusion: inclusion and exclusion in participatory water governance

The WFD Explorer can be interpreted as a site of contestation between the interests of different parties. As such, the WFD Explorer did not entail the emergence of a consensual understanding between these parties about how participatory water quality governance should proceed, but rather entailed an attempt to achieve stabilization of an instrument of governance.

In the above, I pointed towards the various elements that made up the technical code of the WFD Explorer. My discussion of the WFD Explorer presented three challenges its developers came to face. First of all, the attempts of the developers to meet the requirements of their user base created a confusing and chaotic process of implementation. Discrepancies between projected and actual use only became apparent after attempts to implement the WFD Explorer. Secondly, the WFD Explorer failed to become endorsed by its prospective users, who dismissed the output of the WFD Explorer, lamented the lack of transparency of the model, and in some cases even opposed the activity of modeling ecological phenomena altogether. Since users had conflicting ideas concerning the role the WFD Explorer should fulfill, it became rather difficult for the developers of the WFD Explorer to meet the these objections. Thirdly, institutional and professional thresholds shape ideas pertaining to the feasibility of participation. Differences in the agendas of various social groups as well as organizational and institutional thresholds can be rather persistent, and shape negotiations and collaboration between social groups.

The development of the new version of the WFD Explorer shows that participatory water quality governance has changed from a guiding ideal to a possible outcome. However, a crucial motive underlying the development of the WFD Explorer was its perceived ability to act as an instrument for ‘inclusive’ or participatory governance, meaning it would include a multitude of knowledge and social groups. Although the WFD Explorer enables users to study the effects of different measures, its development was and remains largely delegated to a more restricted group of ‘experts’. Thus, the WFD Explorer can become an ‘obligatory passage point’ (Callon, 1986) in water quality governance, which limits the latter’s content and audience: the development of the WFD Explorer will require some uniformity, which might not accommodate the interests of all prospective users of the WFD Explorer. In addition, the viability of the WFD Explorer in the political arena depends on a degree of standardization, which does not necessarily correspond with the ideal of inclusive forms of politics. Although standardization may imply exclusion, it is also needed in a political context. In terms of instrumentalization theory, technologies of governance imply a technical code, and as a result do not always correspond neatly with commitments to include a variety of knowledge and social groups, which is a hallmark of inclusive forms of politics.

In sum, the ‘communication landscape’ opened up by the WFD Explorer is not a smooth ‘Habermasian’ space devoid of power in which ideas are exchanged freely and openly, but fraught with power relations that establish or maintain hierarchies between social groups. The effects and sources of these dimensions of power need to be studied since they shape what knowledge is included in instruments of governance and determine who is allowed to participate. The WFD Explorer’s history reveals a tension between standardization and participation. If water quality governance leans more heavily towards standardization, it may reinforce existing hegemonic approaches to water quality and thereby exclude knowledge and/or social groups. However, if water quality governance leans more towards participation, its legitimacy in the political arena may be compromised since it cannot meet the requirements posed by policy making on a national and European level. Instruments of governance will involve a tradeoff between standardization and participation, and should be studied in terms of exclusion of knowledge and/or groups. Assessing the inclusive potential of technologies of governance is not just a matter of improving their technical design, but entails non-technical elements in the form of interests of social groups as well. May the study of such non-technical elements open vistas towards more inclusive forms of governance that refuse to rely on a politically stale interpretation of the role of technologies of governance.

References

Barry, A. (2001). *Political machines: Governing a technological society*. London, England: Athlone Press.

Bijker, W. E. (1995). *Of bicycles, bakelites, and bulbs*. Cambridge, MA: MIT Press.

Braun, B., & Whatmore, S. J. (2010). The stuff of politics: An introduction. In B. Bruce & S. J. Whatmore (Eds.), *Political matter: Technoscience, democracy, and public life* (pp. ix–xl). London, England: University of Minnesota Press.

Brown, T. (2008). Design thinking. *Harvard Business Review*, 84–92.

Callon, M. (1986). Elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In L. John (Ed.), *Power, action and belief: A new sociology of knowledge?* (pp. 196–233). London, England: Routledge.

Callon, M., Lascoumes, P., & Barthe, Y. (2009). *Acting in an uncertain world: An essay on technical democracy*. Cambridge, MA: MIT Press.

European Union (2000). *DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy.* Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060.

Explorer, Consortium WFD. "WFD Explorer: Development of the Prototype." (Original title: KRW Verkenner: Onwikkeling van het prototype). Delft: Deltares, 2005.

Feenberg, A. (1999). *Questioning technology*. London, England: Routledge.

Feenberg, A. (2002). *Transforming technology: A critical theory revisited* (2nd ed.). New York, NY: Oxford University Press.

Feng, P., & Feenberg. A. (2008). Thinking about design: Critical theory of technology and the design process. In P. E. Vermaas, P. Kroes, A. Light, & S. Moore (Eds.), *Philosophy and design* (pp. 105–118). Berlin, Germany: Springer.

Harteveld, C. (2011). *Triadic game design: Balancing reality, meaning and play*. London, England: Springer.

Hoeven, N., Aerts, J., Klis, H., & Koomen, E. (2009). An integrated discussion support system for new Dutch flood risk management strategies. In S. Geertman & J. Stillwell (Eds.), *Planning support systems: Best practice and new methods* (pp. 159–174). Dordrecht, Netherlands: Springer.

Huitema, D., Mostert, E., Egas, W., Moellenkamp, S., Pahl-Wostl, C., & Yalcin, R. (2009). Adaptive water governance: Assessing the institutional prescriptions of adaptive (co-)management from a governance perspective and defining a research agenda. *Ecology and Society, 14*(1), 26.

Hutchins, M. K., Penning, U. E., Icke, J., Dilks, C., Bakken, T., Perrin, C., . . . Candela, L. (2006). The BMW model evaluation tool: A guidance document. *Archiv fur Hydrologie: Large Rivers Supplement, 17*, 23–48.

Icke, J., van Heeringen, K.-J., Groot, S., & Ouboter, M. (2006). Model evaluation tool experiences for the Amstel River basin. *Archiv fur Hydrobiologie Supplement*, *161*(1–2), 97–113.

Jasanoff, S. (1990). *The fifth branch: Science advisers as policymakers*. Cambridge, MA: Harvard University Press.

Lagacé, E., Holmes, J., & McDonnell, R. (2008). Science–policy guidelines as a benchmark: Making the European water framework directive. *Area, 40*(4), 421–434.

Marres, N., & Lezaun, J. (2011). Materials and devices of the public: An introduction. *Economy and Society, 40*(4), 489–509.

Moody, R., Kouw, M., & Bekkers, V. (2013). Virtually visual: The visual rhetoric of GIS in policy making. In P. Wouters, A. Beaulieu, A. Scharnhorst, & S. Wyatt (Eds.), *Virtual knowledge: Experimenting in the humanities and the social sciences* (pp. 127–149). Cambridge, MA: MIT Press.

Moore, A. (2010). Beyond participation: Opening up political theory in STS. *Social Studies of Science, 40*(5), 793–799.

Mostert, E., Junier, S., Ridder, D., Interwies, E., Bouleau, G., Bots, P., . . . Richard, S. (2009). *Innovative instruments and institutions in implementing the water framework directive: Inception Report* (Research Report No. 1). Limoges, France: Office International de l'Eau.

Pilkey, O. H., & Pilkey-Jarvis, L. (2007). *Useless arithmetic: Why environmental scientists can't predict the future*. New York, NY: Columbia University Press.

Pinch, T., & Bijker, W. E. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social Studies of Science, 14,* 388–441.

Reeze, A.J.G., and B. de Vlieger. "WFD Explorer Ecology 1. Improvements and Further Development 2. Literature Review Measure-Effect Relationships." (Original title: KRW Verkenner Ecologie 1. Verbeterpunten en verdere ontwikkeling 2. Literatuuroverzicht maatregel-effect relaties). Apeldoorn: Arcadis, 2009.

Valkering, P., Tàbara, J. D., Wallman, P., & Offermans, A. (2009). Modelling cultural and behavioural change in water management: An integrated, agent based, gaming approach. *Integrated Assessment Journal, 9*(1), 19–46.

van Schijndel, S. (2006). The planning kit: A decision making tool for the Rhine branches. In J. van Alpen, E. van Beek, & M. Taal (Eds.), *Floods, from defence to management* (Proceedings of the 3rd International Symposium on Flood Defence, Nijmegen, 25–27 May, 2005, pp. 763–769). London, England: Taylor and Francis Group.

Whatmore, S. J., & Landström, C. (2011). Flood apprentices: An exercise in making things public. *Economy and Society, 40*(4), 582–610.

Wyatt, S. (2008). Technological determinism is dead: Long live technological determinism. In E. J. Hackett, O. Amsterdamska, M. Lynch, & L. Wajcman (Eds.), *The handbook of science and technology studies* (pp. 165–180). Cambridge, MA: MIT Press.

Wyatt, S., & Henwood, F. (2006). The best bones in the graveyard: Risky technologies and risks in knowledge. In C. Timmerman & J. Anderson (Eds.), *Devices and designs: Medical innovation in historical perspective* (pp. 231–248). Houndmills, England: Palgrave Macmillan.

Wynne, B. (1996). May the sheep safely graze? A reflexive view of the expert-lay knowledge divide. In S. Lash, B. Szerszynski, & B. Wynne (Eds.), *Risk, environment and modernity: Towards a new ecology* (pp. 44–83). London, England: SAGE.

Wynne, B. (2002). Seasick on the third wave? Subverting the hegemony of propositionalism: Response to Collins & Evans (2002). *Social Studies of Science, 33*(3), 401–417.